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Executive Summary

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Lichen Bioaccumulation and Bioindicator Study Near Alliant Energy – WPL Columbia Energy Center

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EXECUTIVE SUMMARY

Date of Report: OCTOBER 2005

Title of Project:

LICHEN BIOACCUMULATION AND BIOINDICATOR STUDY NEAR ALLIANT ENERGY – WPL COLUMBIA ENERGY CENTER

Principal Investigator Susan Will-Wolf, Dept of Botany, University of Wisconsin-Madison

Project Period: October 1, 2002 – June 30, 2005

Object of Research:

Lichens (algae and fungi live together to form these ‘organisms) are known worldwide as excellent indicators of air pollution effects; tolerant lichens accumulate pollutants in their tissues and sensitive lichens decline with pollution, thus changing lichen community composition. Forest lichen community composition is also a useful indicator of general ecosystem conditions, varying with both general environment and with tree species composition of the forest. Will-Wolf surveyed forest lichen communities in 1974 and 1978, primarily to assess the impact of the new (1975) Alliant Columbia coal-fired electric power generating facility near Portage, Wisconsin. We repeated the surveys in 2003 to assess the long-term impact of the on these lichen communities.

Our new project combines 1) mathematical modeling of modern and historical concentrations of SO₂ from the Alliant Columbia Facility pollution point source, 2) measurement of lichen community composition (species presence and abundance) at 29 sites around the point source, and 3) measurement of mercury, sulfur, and heavy metals concentrations in tissue of selected lichen species at most of those same sites. 24 of the 29 lichen community survey sites are the same as those surveyed in 1974 and 1978, while 5 are close. This provides the opportunity to (1) assess long-term impact of pollution from Columbia on nearby lichen communities, (2) assess long-term changes at "background" sites farther from the facility, and (3) evaluate biological responses in light of relative pollution levels indicated by modeling and lichen tissue element concentrations. Results of this study are applicable to other areas in Wisconsin.

Summary of Results/Accomplishments:

- A modern dispersion model successfully estimated ground –level concentrations of SO₂ from the Alliant Energy – WPL Columbia Energy Center coal-fired generators. These concentrations provide an excellent estimate of relative impact of Columbia emissions in the south-central Wisconsin region of the study, but not of absolute impact because calibration against measured SO₂ at monitoring stations was not completed.
- Tissue samples from two common lichen species were found to provide reliable data on concentration of Sulfur, Mercury, and other elements. Mercury data showed similar low concentrations across the study area. Data for Sulfur and heavy metals clearly indicated that Columbia is a source of enrichment for these elements in lichen tissue. Analysis showed there is an additional pattern of higher Sulfur in the western part of the study area apparently unrelated to Columbia or to other known pollution sources.
- Oaks decreased from 1974 to 2003 and other tree species increased at the oak forest

lichen community study sites. Forests became shadier at most sites. Important variation from drier oak forests to more moist oak forests has been maintained over time. Forests at two groups of sites changed in different ways: A group of more isolated woodlots at more eastern sites had increases of disturbance-adapted tree species. A group of more western sites in more continuously forested landscapes had changes consistent with natural succession patterns. Differences between these two groups of sites became more important over time.

- Lichen communities on black oak group trunks at the study sites have shown much change over time, with the most important changes related to forest changes rather than to pollution. Sun-loving lichens mostly decreased and shade-loving lichens mostly increased from 1974 to 2003. Lichen communities differ at sunnier, drier sites vs shadier, more moist sites in both 1974 and 2003, in parallel to variation of tree communities. The strong distinction of two site groups based on tree species did not appear to be as important for lichen communities, but lichen communities at more east and southeast sites have become more different over time from those at more west and northwest sites.
- An east-west gradient was important for lichen tissue Sulfur concentrations, for tree species composition, and for lichen species composition. It is at least partially correlated with forest fragmentation, and for lichen and tree communities the pattern has strengthened over time, but the causes for this gradient remain obscure.
- Impact of pollution from Columbia on lichen communities has been relatively minor over the time of its operation, and effects do not seem to have increased over time. Reanalysis of the original 1974-1978 study with improved estimation of Columbia impact from modeling shows impact then was probably less than reported in Will-Wolf (1980a). However, for 1974-1978, for 1974-2003, and for 2003, some significant impacts of Columbia on lichens are demonstrated. We cannot relate this minor impact on lichen communities to absolute pollution concentrations at this time.

Future Directions/Activities:

- The Columbia dispersion model pollution estimates should be calibrated with other dispersion models and with existing measured SO₂ data from monitoring stations to establish absolute concentrations of SO₂ from Columbia in the study area. This would allow calibration between concentrations of elements from Columbia, lichen tissue element concentrations, and lichen species and community responses. Such calibration is very useful for establishing thresholds for effects; it also facilitates better comparison of this study with others and facilitates extension of impact assessment to other areas.
- Our findings that forest communities are changing in different ways possibly linked to land use, and that lichen communities appear to be affected more by forest change than by current pollution, should be investigated further. Causes for the east-west gradient in lichen tissue Sulfur concentration and its possible links to land use and forest and lichen community composition also need to be investigated. The potential linkage of these patterns to each other and to human land use has important implications for forest change and ecosystem integrity throughout southern Wisconsin.

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